IS 4049-1 (1988): Formed Ends for Tanks and Pressure Vessels, Part 1: Based on Outside Diameter basis [MED 17: Chemical Engineering Plants and Related Equipment]

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UDC 621·642·34+621·642-986 (Second Reprint JUNE 2001)

Indian Standard

SPECIFICATION FOR FORMED ENDS FOR TANKS AND PRESSURE VESSELS

PART 1 BASED ON OUTSIDE DIAMETER

(Second Revision)

1. Scope — Specifies the profile dimensions, and technical delivery conditions of dished and flanged, pressed or spun ends designed on the basis of outside diameter commonly used as end closures of pressure vessels, receivers, tanks and similar equipments.

1.1 Where the ends have reinforced or flanged-in manholes, it is recommended that they are made to the same geometric shape as the plain ends.

2. Types and Ends — The ends shall conform to one of the following shapes.

2.1 Deep dished and flanged ends with an internal height of dishing h approximately equal to one-quarter of the inside flange diameter d_1 for pressure vessels, either:

a) of semi-ellipsoidal shape with the inner contour of a true ellipse having an axis ratio of 2 : 1 with outside diameter as given in Table 1, or

b) of torispherical shape (*see* Table 1).

2.2 Dished and flanged ends with an internal height of dishing h_1 slightly less than one-fifth of the inside flange diameter d_1 suitable for pressure vessels (*see* Table 2).

2.3 Shallow dished and flanged ends (*see* Table 3) for tanks and other non-pressure vessels.

Note 1 — IS : 2825-1969 'Code for unfired pressure vessels' specifies that in the case of dished and flanged ends, the inside redius of dishing (knuckle radius) shall preferably be not less than 10 percent of the inside diameter and in no case less than 6 percent of the inside diameter or three times the thickness, whichever is more (Tables 1 and 2).

Note 2 — In the case of ends of partial spherical form, the internal height of dishing h_1 and external height of dishing h_0 can be determined as follows:

$$h_1 = R_1 - \sqrt{\left(R_1 - \frac{D_1}{2}\right) \times \left(R_1 + \frac{D_1}{2} - 2r_1\right)}$$

$$h_0 = R_0 - \sqrt{\left(R_0 - \frac{D_0}{2}\right) \times \left(R_0 + \frac{D_0}{2} - 2r_0\right)}$$

where

D_0 and D_1 = outer and inner diameters of dished ends respectively,

R_0 and R_1 = outer and inner crown radii respectively, and

r_0 and r_1 = outer and inner corner (knuckle) radii respectively.

3. Dimensions

3.1 *Flange and Dishing Diameter* — The outside diameter, the crown radius and inside knuckle radius shall conform to the requirements of Tables 1 to 3.

3.2 *Thickness* — Minimum thickness is the thickness measured at the thinnest point after manufacture of the dished ends.

Nominal thickness is the thickness of the plate used in manufacturing of the dished end.

The minimum thickness shall be supplied by the purchaser based on internal/external pressure and other design loading inclusive of corrosion/erosion allowances according to IS : 2825-1969. For non-pressure vessels and tanks, the minimum thickness shall be as agreed to between the manufacturer and the purchaser.

3.3 *Length of the Straight Flange* — The length of the straight flange shall not be less than three times the end thickness with a minimum of 38 mm, unless otherwise agreed to between the manufacturer and the purchaser.

3.4 *Tolerances* — The ends shall be true to shape within the following limits, unless more stringent tolerances are specified by the purchaser.

Adopted 18 April 1988 | | Gr 3

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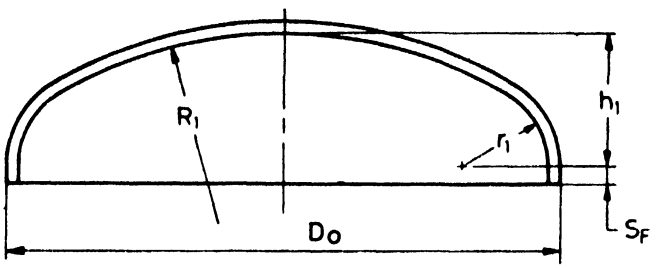
3.4.1 *Circumference* — The outside circumference of the straight flange of the finished end shall not depart from the circumference calculated from the outside diameter by more than the values given in Table 4.

3.4.2 *Circularity* — The difference between the maximum and the minimum outside diameters of the straight flange shall not exceed one percent of the inside diameter and shall, in no case, be greater than $\frac{D_i + 1\,250 \text{ mm}}{200}$.

TABLE 1 DIMENSIONS FOR DEEP DISHED AND FLANGED END (TORISPHERICAL)

(*Clauses* 2.1, 2.3 *and* 3.1)

All dimensions in millimetres.



Outside Diameter D_o	Crown Radius R_1	Inside Knuckle Radius r_1	Length of Straight Flange S_F	Outside Diameter D_o	Crown Radius R_1	Inside Knuckle Radius r_1	Length of Straight Flange S_F
300	240	50		2 000	1 600	300	
350	280	60		2 100	1 680	350	
400	320	60		2 200	1 760	350	
500	400	80		2 300	1 840	350	
600	480	100		2 400	1 920	400	
700	560	125		2 600	2 080	400	
800	640	125		2 800	2 240	450	
900	720	150		3 000	2 400	450	
1 000	800	150	*See* 3.3	3 200	2 560	500	*See* 3.3
1 100	880	175		3 400	2 640	600	
1 200	960	200		3 600	2 880	600	
1 300	1 040	200		3 800	3 040	600	
1 400	1 120	250		4 000	3 200	600	
1 500	1 200	250		4 250	3 400	700	
1 600	1 290	250		4 500	3 600	700	
1 700	1 360	300		4 750	3 800	800	
1 800	1 480	300		5 000	4 000	800	
1 900	1 520	300					

Note — For h_1 *see* Note 2 under **2.3.**

3.4.3 *Thickness* — From the point where the crown radius R_1 joins the knuckle radius r_1, a gradual thinning is permissible up to a maximum of 10 percent of the thickness or 2 mm, whichever is higher at the point where the knuckle radius r_1 joins the straight portion of the flange end. A similar gradual thinning is permissible for ends of semi-ellipsoidal shape. Due to gathering of material, the thickness in the straight portion of the flange may increase and this shall not exceed 15 percent of the nominal thickness of the plate. Thickness of thinnest point of dished end shall not be less than the minimum thickness specified in the order.

Note — Where dished ends are provided with flanges in man-holes, the thinning is permissible up to a maximum of 40 percent of the nominal thickness of the major axis and 15 percent of the nominal thickness on the minor axis.

3.4.4 *Profile* — The depth of dishing (h_1 or h_0) shall not be less than the theoretical depth by 5 percent of inside diameter nor shall this depth be exceeded by more than 1·25 percent of the outside diameter D_0 of the end.

AMENDMENT NO. 1 AUGUST 1996
TO
IS 4049 (Part 1) :1988 SPECIFICATION FOR FORMED ENDS FOR TANKS AND PRESSURE VESSELS

PART 1 BASED ON OUTSIDE DIAMETER

(Second Revision)

(*Page* 2, *clause* 3.4.1) — Substitute the following for the existing:

'3.4.1 *Circumference* — The outside circumference of the straight flange of the finished end shall not depart from the circumference calculated from the outside diameter by more than the values given below:

Outside diameter up to and including 400 mm :	± 5 mm
Outside diameter over 400 mm :	± 0.25 percent.'

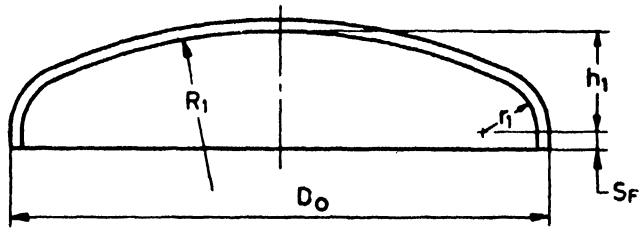
(*Page* 4, *Table* 4) — Delete.

(HMD 17)

Reprography Unit, BIS, New Delhi, India

TABLE 2 DIMENSIONS FOR DISHED AND FLANGED ENDS (TORISPHERICAL)
(*Clauses* 2.2, 2.3 *and* 3.1)

All dimensions in millimetres.



Outside Diameter D_o	Crown Radius R_1	Inside Knuckle Radius r_1	Length of Straight Flange S_F	Outside Diameter D_o	Crown Radius R_1	Inside Knuckle Radius r_1	Length of Straight Flange S_F
300	300	30		2 000	2 000	200	
350	350	40		2 100	2 100	250	
400	400	40		2 200	2 200	250	
500	500	50		2 300	2 300	250	
600	600	60		2 400	2 400	250	
700	700	75		2 600	2 600	300	
800	800	80		2 800	2 800	300	
900	900	100		3 000	3 000	300	
1 000	1 000	100	*See* 3.3	3 200	3 200	350	*See* 3.3
1 100	1 100	125		3 400	3 400	350	
1 200	1 200	125		3 600	3 600	400	
1 300	1 300	150		3 800	3 800	400	
1 400	1 400	150		4 000	4 000	400	
1 500	1 500	150		4 250	4 250	450	
1 600	1 600	175		4 500	4 500	450	
1 700	1 700	175		4 750	4 750	500	
1 800	1 800	200		5 000	5 000	500	
1 900	1 900	200					

Note — For h_1 *see* Note 2 under 2.3.

4. Material — The material of construction shall be carbon steel, low alloy steel, alloy steel or non-ferrous metal. The exact specification shall be specified by the purchaser in his purchase order.

5. Technical Delivery Conditions — The following details regarding technical delivery conditions for dished ends shall be included.

5.1 *Heat-Treated Condition* — The dished ends shall be delivered in the heat-treated condition depending upon the process of dishing, temperature of dishing and the material specification. Heat-treated condition of dished end is a subject of agreement between the manufacturer and the purchaser.

5.2 *Workmanship* — Descaling shall be carried out to measure the dimensions and to carry out visual inspection. Dished ends shall be free of any injurious defects.

5.2.1 Projection, depressions or elongated grooves usually developed during dishing are permissible so long as these depressions are not sharp and their depth is within the tolerance limits specified on the plate. Sharp grooves, laminations and other surface cracks shall be completely removed by grinding or any other suitable method.

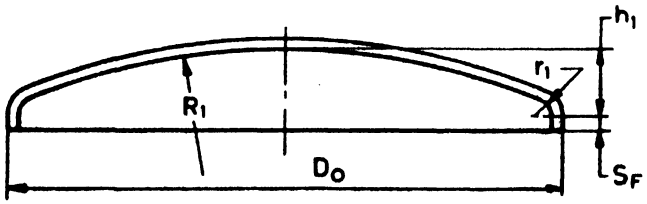
5.2.2 Where depressions exceed the tolerance limits, specified on the plate, such depressions shall be removed by grinding or by welding by an approved welding procedure with the permission of the purchaser. Hammering of surface defects is not permitted.

5.2.3 The heat-treatment and radiography requirements shall be according to IS : 2825-1969.

TABLE 3 DIMENSIONS FOR DEEP DISHED AND FLANGED ENDS FOR TANKS AND NON-PRESSURE VESSELS

(*Clauses* 2.3 *and* 3.1)

All dimensions in millimetres.



Outside Diameter D_o	Crown Radius R_1	Inside Knuckle Radius r_1	Length of Straight Flange S_F	Outside Diameter D_o	Crown Radius R_1	Inside Knuckle Radius r_1	Length of Straight Flange S_F
900	950	50		2 300	3 300	50	
1 000	1 200	50		2 400	3 300	50	
1 100	1 400	50		2 600	3 300	50	
1 200	1 500	50		2 800	3 500	50	
1 300	1 700	50		3 000	3 600	50	
1 400	1 700	50		3 200	4 000	50	
1 500	1 800	50		3 400	4 000	50	
1 600	2 000	50	*See* 3.3	3 600	5 000	50	*See* 3.3
1 700	2 200	50		3 800	5 000	50	
1 800	2 400	50		4 000	5 000	50	
1 900	2 600	50		4 250	5 500	50	
2 000	2 800	50		4 500	5 500	50	
2 100	3 000	50		4 750	5 500	50	
2 200	3 300	50		5 000	5 500	60	

Note — For h_1 *see* Note 2 under 2.3.

TABLE 4 TOLERANCE ON OUTSIDE CIRCUMFERENCE

(*Clause* 3.4.1)

All dimensions in millimetres.

Outside Diameter of Head	Range of Nominal Thickness	Standard Tolerances + or −
300 to 1 200 inclusive	Up to 25 inclusive	10
	Over 25 to 65 inclusive	10
	Over 65 to 100 inclusive	12
Over 1 200 to 2 400 inclusive	Up to 25 inclusive	12
	Over 25 to 65 inclusive	12
	Over 65 to 100 inclusive	20
	Over 100 to 150 inclusive	25
Over 2 400 to 4 500 inclusive	Up to 25 inclusive	20
	Over 25 to 65 inclusive	20
	Over 65 to 100 inclusive	25
	Over 100 to 150 inclusive	40
Over 4 500	Up to 25 inclusive	25
	Over 25 to 65 inclusive	25
	Over 65 to 80 inclusive	40

5.3 *Testing of Dished Ends for Material Quality* — To ensure that the material properties are not impaired during the manufacture of the dished ends, samples taken from dished ends after the final heat-treatment shall be subjected to mechanical test for tensile strength, impact, where necessary (for low temperature applications), and bend tests as specified in the relevant specification for the plate material. The location of test plates shall be subject to agreement between the manufacturer and the purchaser, and may be one of the following:

a) Extended portions cut out from the straight flange,

b) Openings cut-out for nozzles, and

c) Separate test plates from the same melt and heat number subjected to simulation similar to the dished ends.

6. Marking — The dished ends shall be marked with the following:

a) Outside diameter,

b) Type of dished end,

c) Minimum thickness,

d) Material of construction, and

e) Brand/trade name of manufacturer.

6.1 *Standard Marking* — Details available with the Bureau of Indian Standards.

EXPLANATORY NOTE

Formed ends are used as end closures for pressure vessels, receivers and similar equipments. IS : 2825-1969 specifies any one of the following shapes for the ends:

a) Hemispherical,

b) Semi-ellipsoidal,

c) Dished and flanged, and

d) Conical.

In this specification, only semi-ellipsoidal, and dished and flanged ends are covered. The code for unfired pressure vessels (IS : 2825-1969) also permits deeper or slightly shallower semi-ellipsoidal ends, and dished and flanged ends deeper than those specified in this standard. But these shapes are considered 'special' and have not, therefore, been included.

This standard, first published in 1968, was revised in 1971 to reduce the number of varieties of dished ends.

Since the formed ends are designated either on outside diameter basis or inside diameter basis, the standard has been revised again and made in 2 parts. The Part 1 of this standard covers formed ends on outside diameter basis, while Part 2 covers that as inside diameter basis.

A material clause, and heat-treatment and radiography requirement have been included in the revision.

The information to be supplied by the purchaser with enquiry or order is given in Appendix A.

APPENDIX A

(Explanatory Note)

The purchaser shall supply the following information to the manufacturer with the enquiry or order:

1) Type of end required;
2) Outside diameter of the dished ends;
3) Material of construction of the dished end,
4) Method of heat treatment;
5) Minimum and nominal thickness of the dished end;
6) Radiography and any other non-destructive testing, if required;
7) Length of straight flange;
8) Whether the flange is to be machined and welded portions required;
9) Special requirements for the welded joints in an end made from more than one plate;
10) Any inspection or survey requirements; and
11) Man-hole or any connection details, if required.